Forward Pixel Detector

Signal Interface

http://ppd.fnal.gov/experiments/forward_pixel/Presentations/Fpix_SI.pdf

Sergey Los for Fpix Group

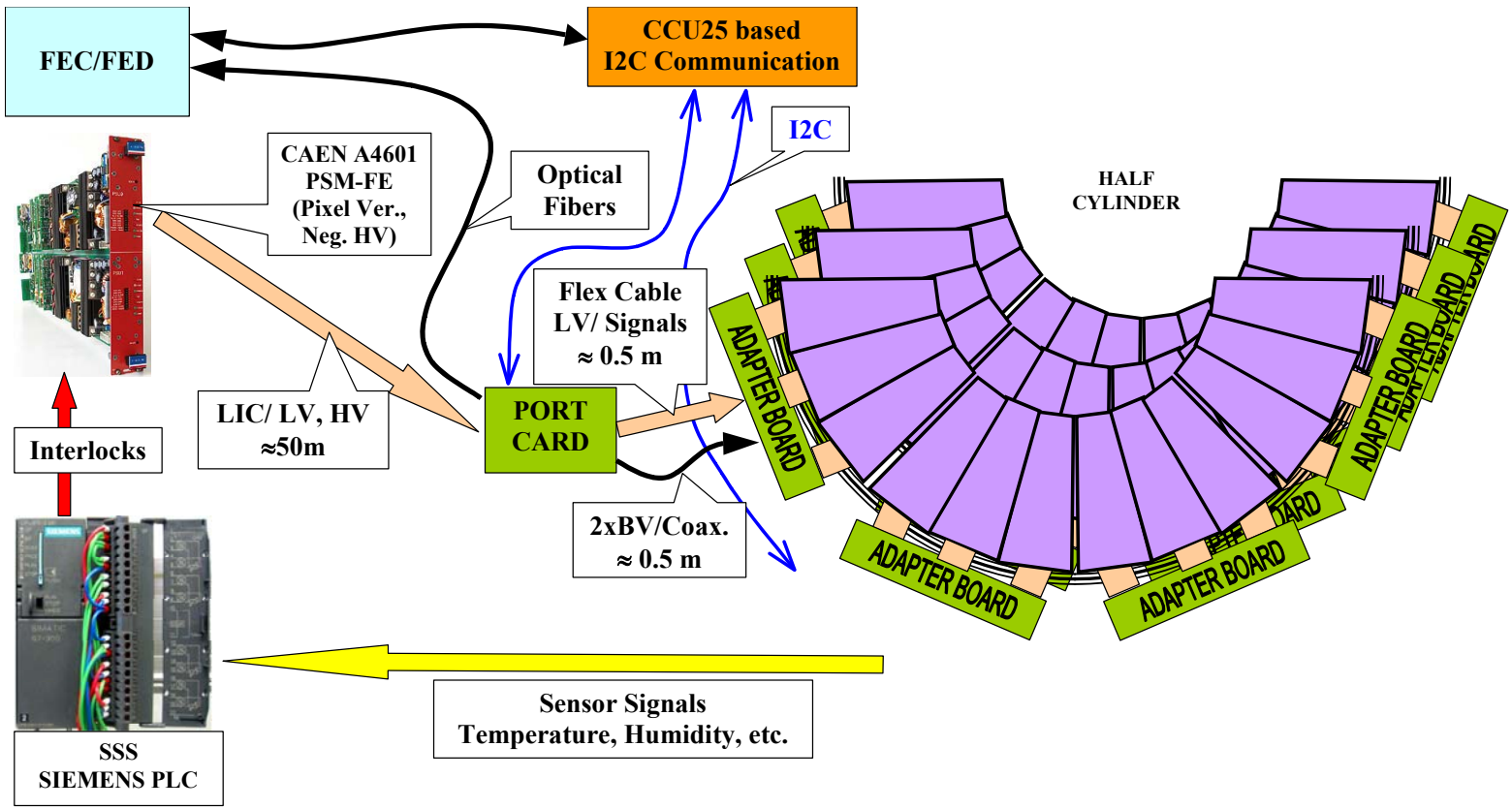
Fermilab

Outline

- Readout and Infrastructure Electronics Layout
- Readout Sector Block-Diagram
- Low Voltage Distribution
- Irradiated Sensor Leakage Current
- High Voltage Power Distribution
- Pixel Power Cable
- Adapter Board Mechanical Concept
- Adapter Board Layout
- Port Card Concept
- Detector Control System
- Detector Safety System

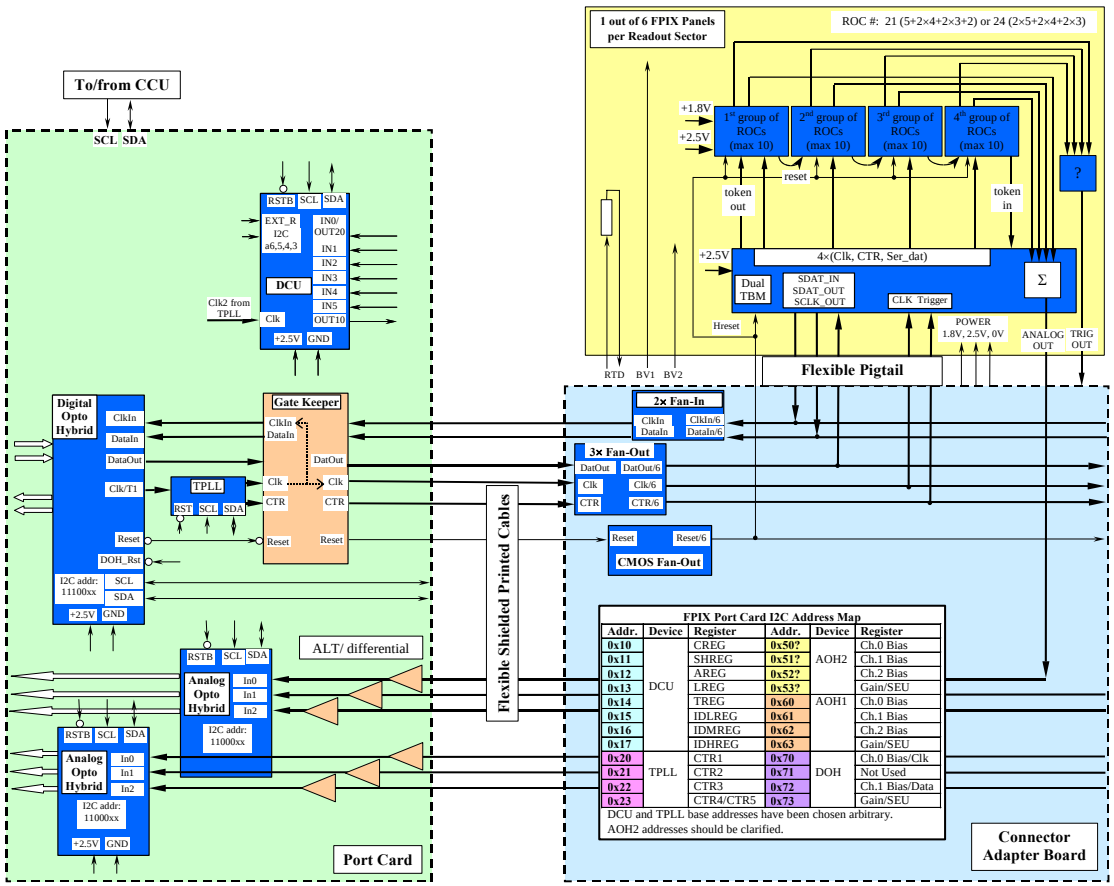
FPix Readout and Infrastructure Electronics Layout

- We are trying to follow Tracker – Barrel Pixel design mainstream.
- Different geometry requires some adjustments.



FPix Readout Sector Outline

- One Port Card/Adapter Board provides Readout/Support for 3 detector Blades
- AOH being designed to allow two devices on a single I2C channel.



FPix Low Voltage Distribution

- There are 135 PSI-46 ROCs on three FPix Blades:
  - **Vdigital (2.5V@4.8A)**
  - **Vanalog (1.8V@4.1A)**
  - **Vcontrol (2.5V@1.0A)**
- The low voltage power for three blades can be provided comfortably with a 1/2 of a single CAEN A4601 Power Supply module

- Tracker specified CAEN A4601 PS module has two independent units with the following current capacities:
  - **2 LV (7&13A @ 8V)**
  - **2 HV (20mA @ 600V)**
- Total FPix need: 24 modules for FE electronics
- One power crate can house up to ten modules

Irradiated Sensor Leakage Current

(courtesy Gino Bolla bolla@fnal.gov)

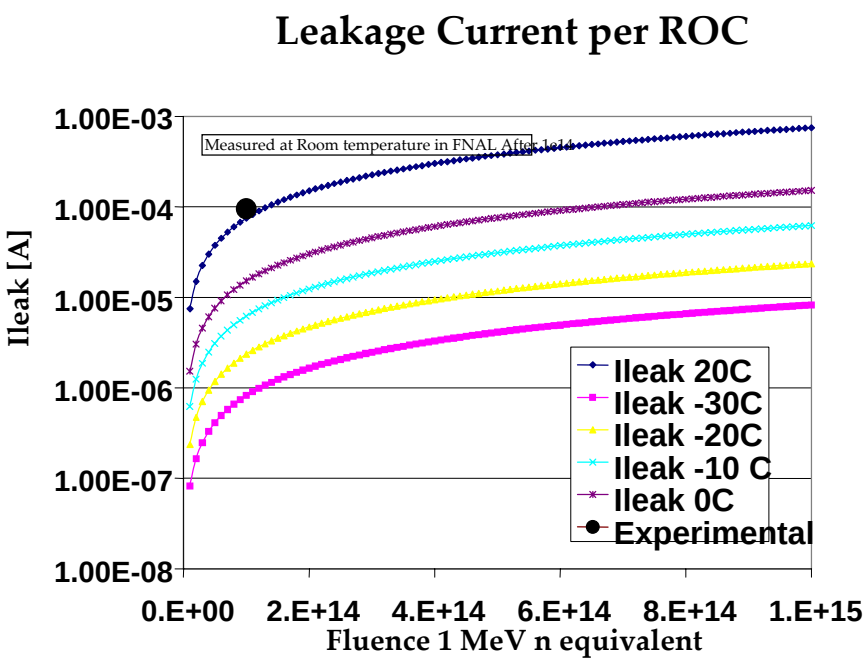


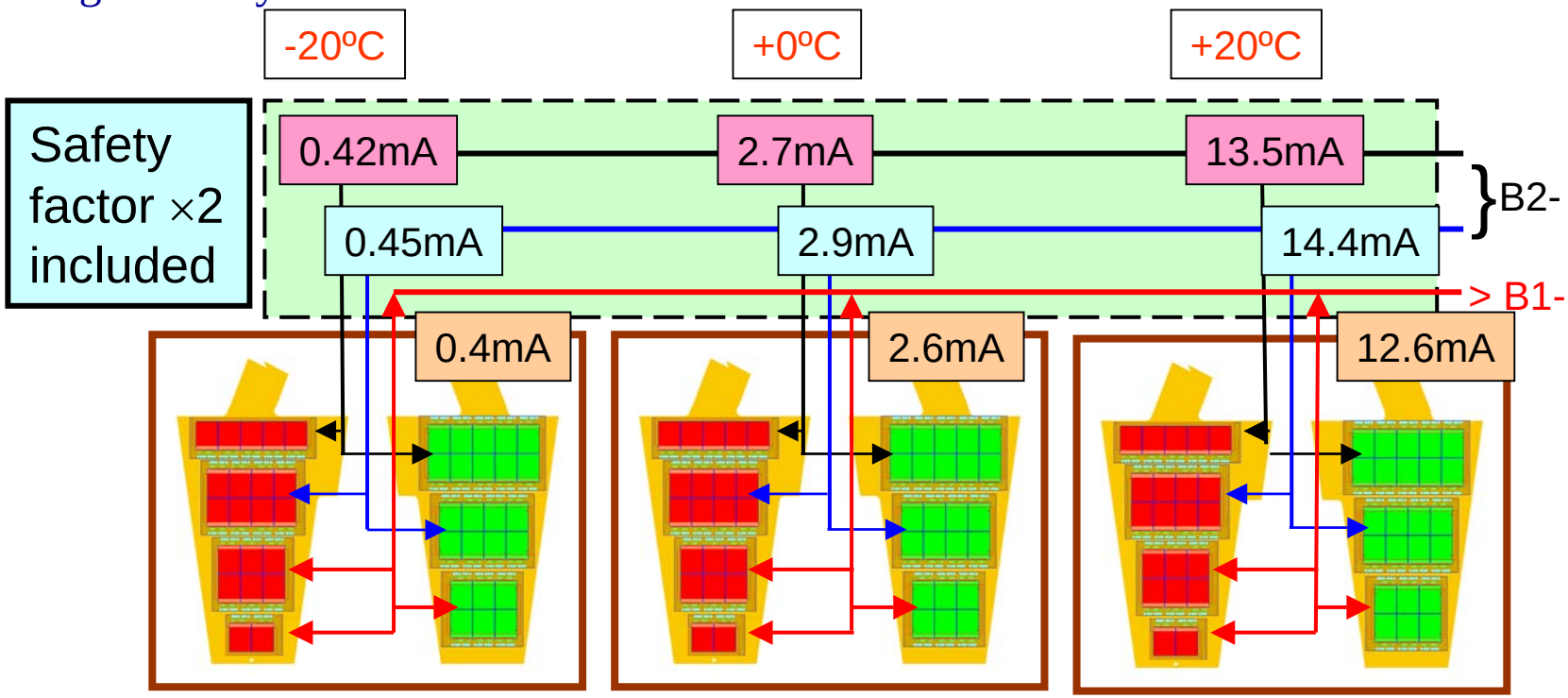
Figure 1 Expected leakage current per ROC versus integrated delivered fluence. Different curves represent different temperatures for the sensors. There is only one experimental point measured at room temperature in SiDet after an exposure to 1E+14 at IUCF.

Running temperature	Maximum expected leakage current per ROC	Safety factor	HV Power supply Specifications per ROC
20° C	4.5E-4 A	2	**1 mA**
0° C	9.1E-5 A	2	**0.2 mA**
-10° C	3.7E-5 A	2	**0.1 mA**
-20° C	1.4E-5 A	2	**30 μA**
-30° C	4.9E-6 A	2	**10 μA**

Table 1 Expected leakage current per ROC from the plot of Figure 1 at an integrated fluence of 6E14 and power supply specification versus maximum running temperature. A safety factor of 2 has been chosen in order to translate the expected current into power supply specification.

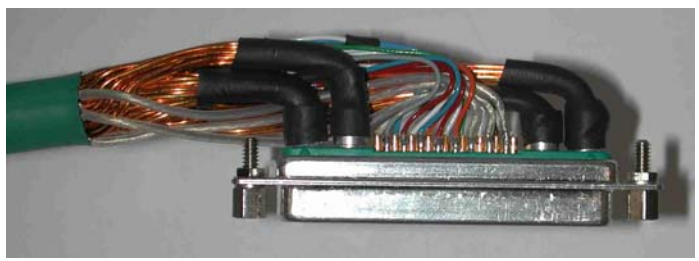
FPix High Voltage Power

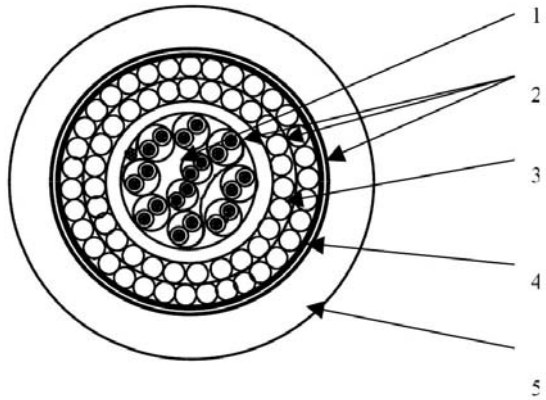
- Two independent Bias Voltages (BV) used for the inner and outer radius plaquettes to allow different voltages in compensation of radiation damage.
- Six Detector Panels, connected to the same **Adapter Board,** share the same Outer and Inner BV. Up to the operating temperature of +0ºC BV can be provided by a single A4601 PSU (Pixel version with negative polarity). This granularity matches well the LV distribution.



Pixel Power Cable

- Tracker **Low Inductance Cable** (**LIC**) was adopted for the Pixel power distribution. **D-Sub 21WA4** connector provides 4×40A, and 17×5A contacts.
- Due to similar requirements and segmentation it would be very convenient to use the exact same cable and power supply configuration as the **Barrel** does.
- As the Va and Vd have separate return conductors in the cable, it would be to a further advantage to have a power supply with independent LV outputs.



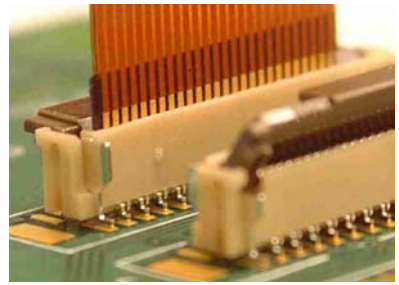


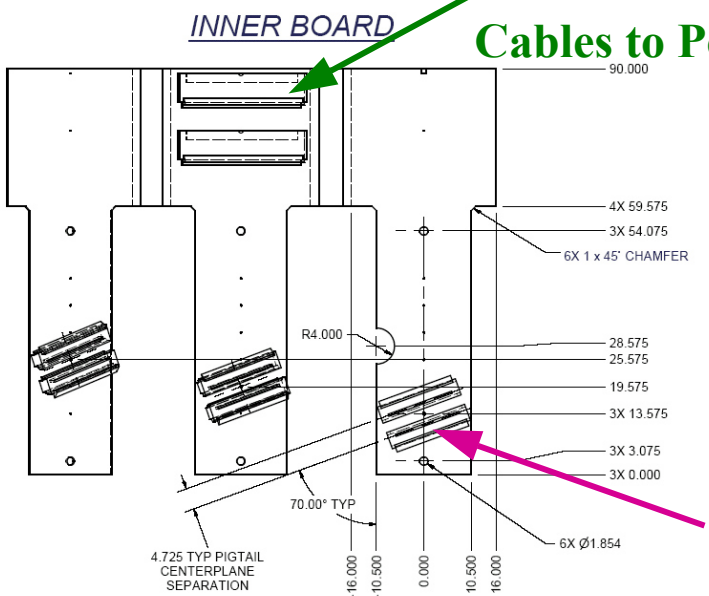
1. **Eight pairs, tinned copper 0.14mm^2, AWG 26, 600V, in a common shield. Two pairs out of the shield.**
   - **BV conductors.**
   - **LV sense wires.**
   - **Shield is terminated to a connector pin.**
2. **Polyester tapes.**
3. **50 enameled copper conductors, 0.57mm^2, AWG20.**
   - **Used for +Va, +Vd, and Returns**
4. **Tinned copper braid, 85% coverage with 0.75mm^2 drain wire.**
   - **Terminated to a connector pin.**
5. **Jacket, 0.8mm, max O.D. 11.5mm, radiation resistant compound.**

Adapter Board Mechanical Concept

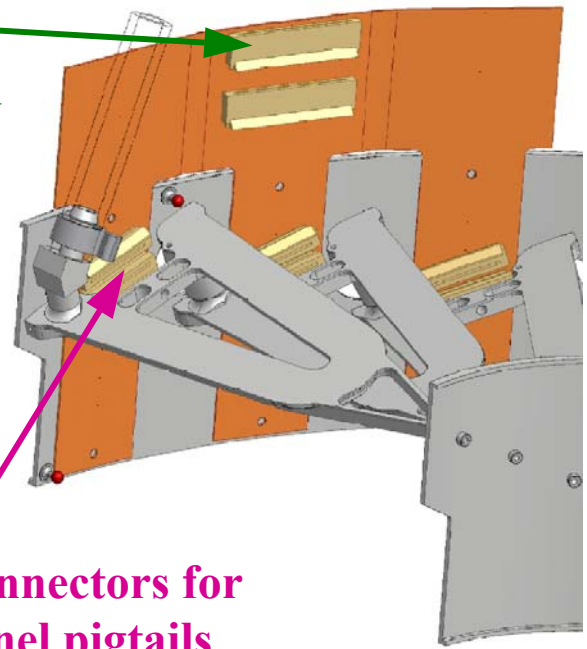
(design by Greg Derilo)

- **Flexible Adapter Board concept is being pursued.**
- **Tree "fingers" with FR4 stiffeners and 90º 0.5mm FPC connectors go under the Cooling Channels for direct connection with the Panel signal pigtails.**



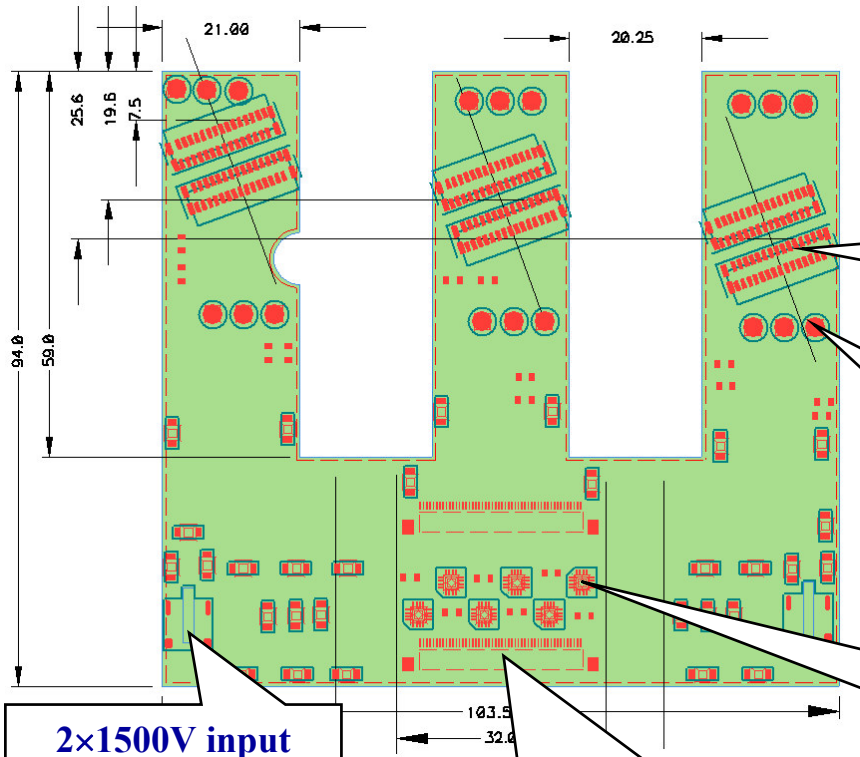


FPC Connectors for the Extension Cables to Port Card

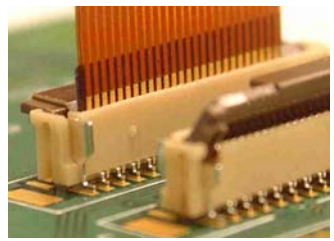


FPC Connectors for the Panel pigtails

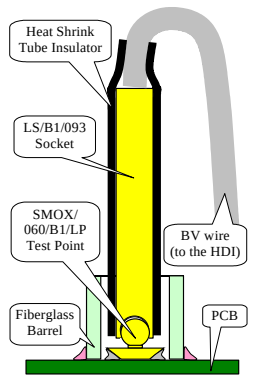
Adapter Board Layout



6×30-pin connectors for the Panel pigtails

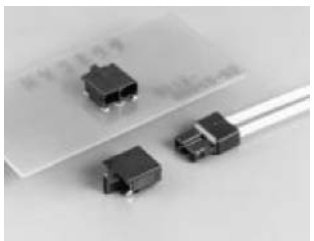


Individual wire-to board BV connectors, something like that:

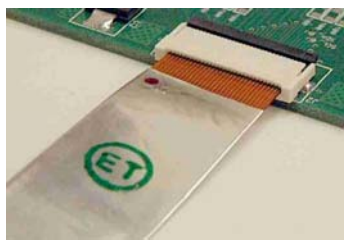


6 × Fan-In, Fan-Out ASICs

2×1500V input BV connectors



2×50-pin connectors for extension cables to the Port Card

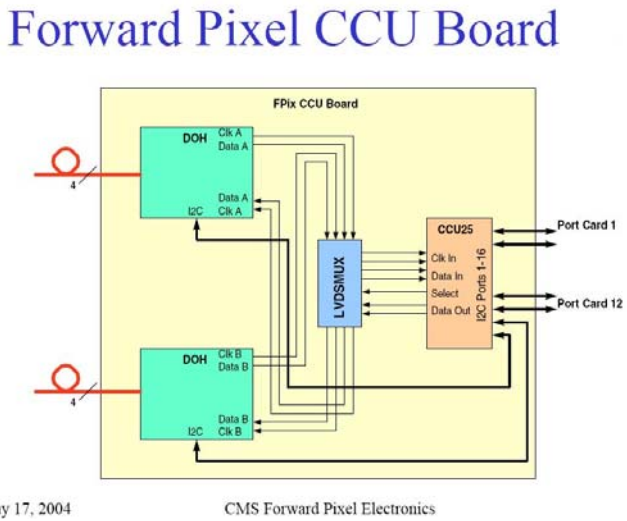


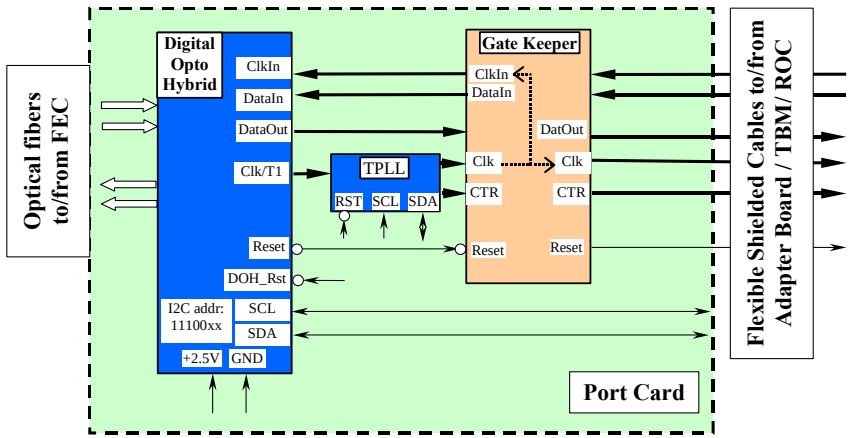
FPix Port Card Concept

- Port Card is connected to the Adapter Board by means of two extension cables, and provides all power and communication needs for three detector blades.
- Besides of one DOH and two AOHs, there are several other ASICs on the board: Gate Keeper, TPLL, DCU, and two ALTs.
- BV doesn't have to be brought to the Port Card.
- Extension cables from three detector disks follow the same path along the Service Cylinder. Special consideration should be given to the extraction of the lower cables first. We are considering three possible solutions:
  - Folding the cables so they go around as indicated on the picture. Shielded cable is somewhat stiff.
  - Using a flexible board for the Port Card with the connector flap going under the cable stack.
  - Running cables on top of the Port Cards.

FPix DCS

- DCS hardware is based on the modified Tracker DOHM-CCUM solution for the I2C destinations.
- A 40 MHz serial communication channel via FEC – DOH – TPLL/GateKeeper is used for the ROC/TBM register downloads.

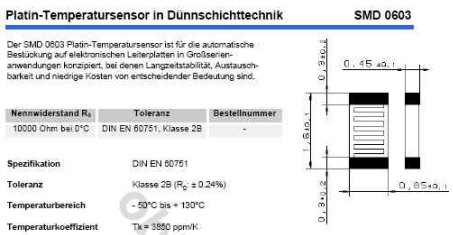


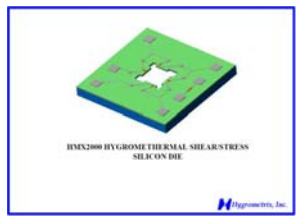


- I2C communication channel serves two main purposes:
  - Download the setup parameters to the Port Card ASICs.
  - Read out the environmental sensor data from the sensors connected to the DCU.

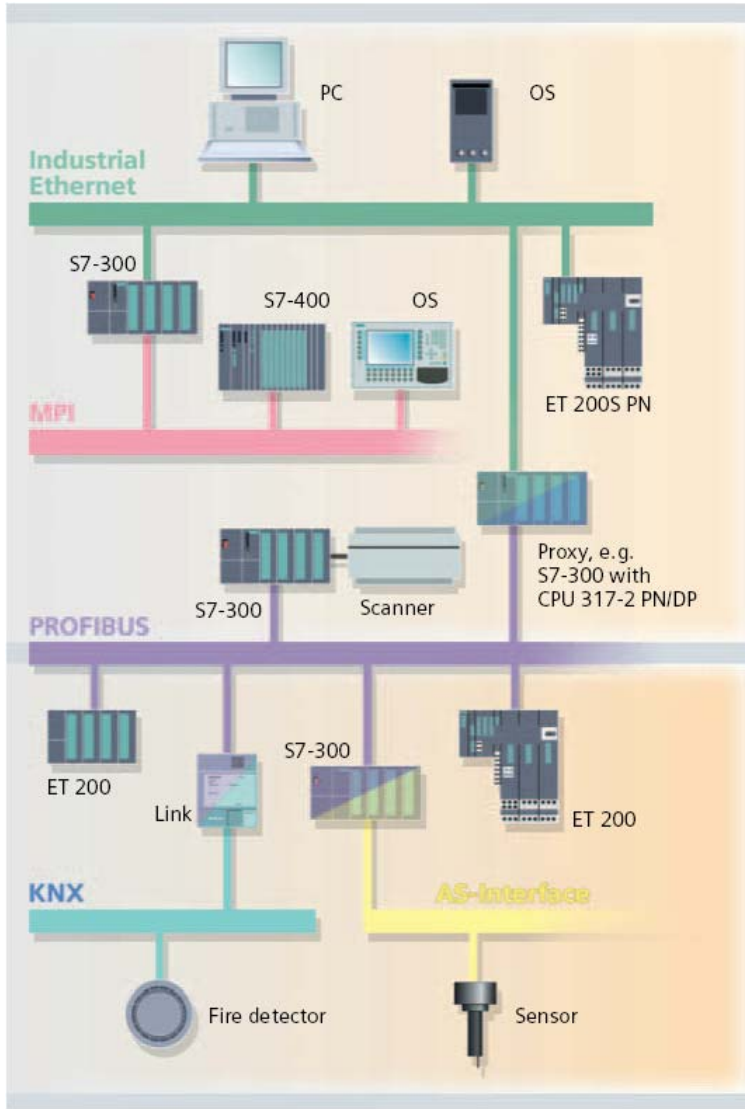
FPix DSS

- DSS (Interlock System) is based on the adaptation of the Tracker SIEMENS PLC solution
- Separate Control cables are used to directly connect the DSS sensors to the PLC modules
- Interlock signals are sent to the PS crates





- **Platinum RTDs located on the Blades and HMX2000 humidity sensors are planned to be used for the DSS**
- **Other input/output destinations include detector chiller, nitrogen purging system, and operator**
- **Care should be taken to minimize noise injected into the system by the Control cables and the sensors**



The S7-300 can be connected to all kinds of networks

Conclusion

- Conceptual design of the Adapter Board is complete and engineering design has been started
- Conceptual design of the Port Card is progressing
- Distribution of HV and LV power is analyzed and understood
- Concepts for FPix DCS and DSS have been developed